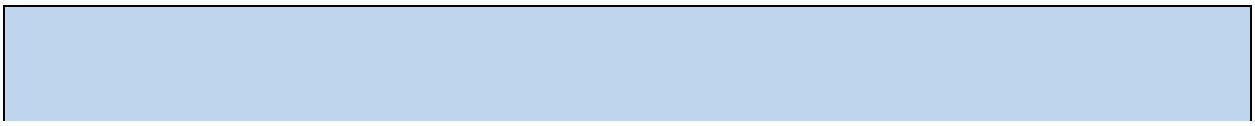
Member Communication Experience

Any views and opinions expressed in this article may or may not reflect the

question reflects the engineering roots of project execution and the post-disaster experience that has already occurred such that building back even better is an essential tenant.

Outlining some of the systems of systems challenges that society will likely face can provide a framework to discuss the emergent nature of both the challenges and the potential resultant outcomes. Drawing attention to some of the driving forces acting on this system of systems as well as the national and sectoral programs that may emerge as a result will provide insights on how to respond. Highlighting some of the feedback loops that may exist or emerge from both apparent and hidden coupling also may provide an increased understanding ab4 (al tenba2 T5s52 792 reW*nBT/TT0 10.98 Tf167.72 593.38 Td[(u)-3.998 mergent)



		to market outcomes are always first produced and consumed.
	Technology development and disruptive ability is important	The simplest disruptors will win the day.

Considering the scale of this system of systems challenge, now highlighted are some of the systems that are constituents in this broad endeavor. They include:

of future on-again/off-again political reversals must be considered a real possibility, and not just for the U.S.

Another example of a recently emergent challenge was driven by the COVID-19 pandemic during 2020. During this period, a broad drop in economic activity globally occurred as various shutdown and quarantine measures were implemented. Carbon emissions were reduced by an estimated 17 percent, but global CO_2 concentrations continued to increase. This has reinforced some skeptical views that climate change[3] is not a man-made phenomenon.

Increased emissions of nitrogen and oxygen from ammonia and electrolysis processes.
Free riders gaining short-term competitive advantage.
Political instability from various dislocations

pandemic cause a significant reduction in global population, reducing demand for greenhouse gas producing food, materials, and energy?

Demand for key renewable materials (lithium, cobalt,[6] nickel) drive new regional conflicts with the potential to degrade into a limited superpower conflict.

Digitalization of society creates growing energy demands that impact the rate of energy transition.

Temporal dislocations between action and effect create challenges in sustaining commitment and investment. Lags stretching from years to decades can be reasonably expected between meaningful actions and measurable results (thermal inertia; random variations; ecosystem resilience; social resilience; denial; missing governance structures; social resistance; investment lags; research and development lags; carbon cycle inertia; diffusion of innovation; sink flow reversals/search for equilibrium). This is further compounded by natural background variations and the previously described existence of significant sinks.

Reforestation efforts are negatively impacted by climate trends already underway. New areas suitable for afforestation must compete with agricultural uses similarly affected by global climate change. Biodiversity and ecosystems are also affected. Political factors that arise limit the agility of a response.

Direct air capture of carbon technologies, while providing benefits, delays s[illegible]
industries. Apparent net zero cement, plastics, and fuels are found to notTf81 402.6ltBT/TT0 10.[andot007 /TT]p(und)-2

Yet a herd of Black Elephants (rare and significant risks that all acknowledge but do not want to discuss) is growing and becoming more dangerous with each passing day. Addressing this herd will result in missteps and potential loses, some likely significant. But inaction could result in complete loss.

In addressing climate change, a risk appetite needs to be adopted, one that recognizes the high degree of uncertainties and accepts that failures and unintended consequences along the way are inevitable. This appetite must include a healthy dose of acceptance of these realities, but also include mechanisms to learn, transparently, and fail forward.

The metrics by which risks are assessed will evolve as society learns more about the presence of Black Elephants, the intervening terrain, and the improvements they will require.

The base against which risks are measured will be changing. This continuous reassessment of risk will act to redefine desired outcomes, rates of action, and reweight tradeoffs against other societal risks. New risks, previously unseen or underappreciated both within the global climate change domain but more

highly influenced by the collective perceptions of others who are part of this system of systems. Those collective other perspectives must be acknowledged and all must attempt to understand them.

As individual and collective perceptions shift so must control strategies and mechanisms. This requires a form and level of engagement not typical in large programs and at an even greater scale.

Program managers have much to bring to meeting the challenge of reversing climate change if they are prepared to think deeper and broader and recognize that all are better than any single one. While policy, principles, and technology may reside in the domains of others, management of these efforts will most assuredly reside with project and program managers.

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